INNOVATION FOR INTERNATIONAL DEVELOPMENT LAB

REQUEST FOR PROPOSALS: 2017 Collaborative Solutions Program

I: Background

The Innovation for International Development Lab (I^{2}D Lab) under the Office of Global Engineering Programs (GEP) supports a vibrant community of faculty, staff, students, and global partners to respond to bottleneck challenges in international development through engineering innovations and market-driven approaches. I^{2}D Lab supports partnerships and grantsmanship for co-design, adaptation, and field-testing of appropriate technologies and services that address unmet market needs aligned with the United Nations' Sustainable Development Goals e.g. energy access, healthcare, water and sanitation, labor-saving innovations, disaster/humanitarian response, etc. Innovations within the I^{2}D scope above may include (a) the development or novel adaptation of products, technologies, or services or (b) applied/translational research.

We have refined our operational model, based on an evolving understanding of the needs of our stakeholders – both from Purdue and external partners. In October 2016 we launched a call for *Requests for Collaboration* to collect challenge opportunities that align with the scope above on an ongoing basis. **We invite interested engineering faculty to apply for the 2017 *Collaborative Solutions Program*** for Partner Challenges (Section VIII).

II: Support Structures

Proposals for **one year of support** (2017 – 2018) are solicited from College of Engineering (CoE) faculty or instructional staff to address the Partner Challenges or your own proposed challenges (Section VIII). **All efforts must be led by Purdue CoE faculty, with one of the following structures:**

(a) **Graduate student support:** Up to one year ½ GA appointment: $21,000 salary plus fee remittance and fringe. In addition, travel and supplies up to $4,000.

(b) **Undergraduate student support:** Travel and/or supplies for credit-bearing undergraduate teams (e.g. I^{2}D Global Design Teams (GDT's), undergraduate research, senior design/capstone, EPICS etc.), up to $6,000.
- If student travel to an international location is proposed, it must be a faculty-led, credit-bearing Study Abroad trip, administered through GEP. The award must partly be used for offsetting student travel costs.
- I^{2}D can assist in recruiting students, assisting with student registration, and mentoring students, as needed.

Due to very limited funds, we expect to make 2 – 3 awards in this cycle. Both structures may be able to apply for renewal for a second year, pending evaluation and the availability of funds. **Awardees are expected to become active participants in the I^{2}D Lab community and promote I^{2}D Lab objectives.**

III: Proposal Submission Process

TWO PAGE Proposals in accordance with the Proposal Template (IV) should be submitted to Andrea Burniske, I^{2}D Lab Program Manager (andreaburniske@purdue.edu).

It is highly recommended that applicants submit a DRAFT PROPOSAL DESCRIPTION as soon as possible but no later than January 27, 2017. I^{2}D Lab can provide feedback on these drafts, and facilitate partner identification and communication. Final proposals are due by **February 10, 2017, 11:59 pm** Purdue time.

Please see next page for proposal and selection timeline.

Proposal and Selection Timeline: 2017 Collaborative Solutions Program

- Monday, January 9, 2017: Request for Proposals released
- Friday, January 27, 2017: *Draft* proposal descriptions due (highly recommended)
- Friday, February 10, 2017: Proposals due to andreaburniske@purdue.edu by 11:59pm
- Friday, March 3, 2017: Selected Teams announced
- Thursday - Friday, March 23 – 24, 2017: Grantee teams present at the I^2D Lab Expo

IV: Proposal Template

FORMAT: Proposal length is limited to **two pages** except as noted below, 8.5” x 11” with 1” margins, 10 point font. Images permitted. Submit as a PDF under 5MB, named *PILastname_TitleKeyword.pdf* to andreaburniske@purdue.edu.

Partner Challenge Title: From those in Section VIII, or your own challenge title
Partner Name(s): From those in section VIII, or your own partner.
Investigator Name(s): PI(s) and, if applicable and known, graduate student. PI must be CoE faculty.
Support Structure: Graduate or undergraduate, with undergraduate program name(s) as applicable.
Description: To include, not necessarily in this order…

- *Introduction or Background* (note there is no need to restate the Partner Challenge descriptions from section VIII)
- *Specific Aims* (of your activity)
- *Preliminary Results* (Current status of your proposed intervention; relevant preliminary results or prior deliverables)
- *Competitive Advantage for International Development* (with respect to other solutions, including cost, environmental, and social aspects)
- *Deliverables* (The expected deliverables from the activity. Include publications, prototypes, etc.)
- *Simple Timeline And Budget* (e.g. graduate student support, travel, and supplies). COEUS budget not required.

Required Supplementary Sections and Appendices *not subject to the two page limit*:

- References
- Biographical sketches of PI and any Co-PIs, no more than two pages each (e.g. NSF format)
- Letter of support from School Head

V: Selection Criteria (evaluated by panel of internal and external experts)

- Completeness of Proposal Package: responses to all questions, and the Required Supplementary Appendices
- Impact potential, including scale and depth of expected beneficiary impact
- Competitive advantage, including economic, environmental, and social aspects relative to existing solutions
- Role of intended beneficiaries, including in problem assessment and solution design
- Intellectual merit, including innovation and research publication potential
- Budget, especially cost-share from entities beyond I^2D, and return on investment with respect to deliverables
- Timeline, including likelihood of intervention field testing during grant period
- Future project potential, including for external support after the grant period
- Partner organization, including demonstrated strength in the relevant topic and location

VI: Awardee Expectations

With details to be provided, it is expected that PIs and any Co-PIs of winning proposals will **become active participants in the I^2D Lab community and promote I^2D Lab objectives. Specifically…**

- Provide brief written or oral progress reports each semester
- Acknowledge I^2D support in all publications and public discussions of the work supported by this grant
- Regularly participate in bi-weekly I^2D meetings
- Demonstrate adequate engagement with the partner, including a field visit to the project location
- Work with I^2D to develop grant proposals to external funding agencies based on work supported by this grant
- Obtain the appropriate IRB approval for research activities involving human subjects

VII: Contacts

Andrea Burniske, I^2D Lab Program Manager, andreaburniske@purdue.edu
Alex Moseson, Managing Director of Global Engineering Programs, alexmoseson@purdue.edu

VIII: I²D Lab 2017 Partner Challenges

The Partner challenges are listed in the following pages.

Proposals outside the Challenges described will also be considered if a partner organization has been identified and is interested to participate in the activity, especially with in-kind or other support. If the partner is not CRS or Unillanos, include in the proposal the partner's…

(1) experience in the proposed country and sector area,
(2) proven capacity to develop and scale solutions,
(3) description of local/international offices in the target country as relevant, and
(4) ability to cost share through financial or in-kind support, or expected collaboration on applications for external funding

We strongly recommend that all candidates submit a draft proposal by January 27, 2017. This is especially true for those proposing partners beyond CRS or Unillanos.

PARTNER CHALLENGE 1: Managing Water for Food

Partner: Universidad de Los Llanos ("Unillanos"), Villavicencio, Meta, Colombia

Background

Water is a key input in food production and processing. It is a resource that can be preserved and reused by applying the principles of circular economics. Around the world, there are diverse water initiatives that increase technical knowledge and capacity to improve water management (agricultural and non-agricultural), help overcome challenges to water availability and use, and provide clean water to millions of people. *Managing Water for Food* seeks to advance agricultural water technologies to benefit smallholder farmers, improving efficiency and yields, and thus livelihoods.

Challenge

Water management is the most significant barrier for production in Orinoquia region of Meta, Colombia, one of the most important areas in the country for food production. The rainy season provides an overabundance of water - particularly in poorly drained soils - followed by a prolonged dry season where water is scarce. Despite this, Colombian smallholder farmers have very low level of access to technologies that allow them to conserve and manage water resources.

Request

We seek technical solutions with scalable business models which will **enable the production of more food with less water and/or make more water available for food production, processing, and distribution** in the Orinoquia Region (Orinoco watershed) of Colombia, using current seeds.

Examples include *but are not limited to:*

Water Efficiency and Reuse

- Improve soil or irrigation to allow better soil moisture retention and reduce evapotranspiration
- Improve water usage for the food value chain in urban and peri-urban areas
- Safely re-use wastewater in agricultural practices, with direct application and use by farmers
- Safely re-use water in multiple agricultural practices e.g. aquaculture

Water Capture and Storage

- Reduce the risks of adverse downstream hydrological effects resulting from increased water storage
    - Data availability must be improved to assess the impact of these effects, and more data is required regarding the locations of sustainable water sources for the food value chain
- Prevent wide-scale microbiological and chemical contamination in stored waters that will be used in the food value chain
- Increase total water storage capacity to consistently meet the combined demands of agriculture and livestock
- Reduce overall water demand in the food value chain to ensure continuous water supply even in periods of drought

Partner Support

The partner can cover some airfare and accommodations.

Relevant Resources

- Refereed Journal Article: Engineering solutions for food-energy-water systems: it is more than engineering
- Refereed Journal Article: Food Production and Water Conservation in a Recirculating Aquaponic System…
- Refereed Journal Article: The Role of Agricultural Engineering to Take Agriculture to Greater Height…
- Grant Program: USAID Securing Water For Food (Innovations)
- Open Source Community: Farmhack
- Practitioner Blog Post: Water and the Greener, Circular Economy (RWL Water)

PARTNER CHALLENGE 2: Potato Storage Technology

Partner: Catholic Relief Services (CRS), Afghanistan

Background

Potato cultivation occurs in all regions of Afghanistan (24 of 34 provinces) and is the major cash crop of the Central Highlands. As with many global highlands, potatoes are typically stored in non-ventilated pits in the field. This method leads to 30-100% loss from potatoes rotting in store, a major concern as stored crops feed subsistence households during the lean period of winter through early spring. Several projects have attempted to introduce improved storage methods to the Central Highlands but have proven prohibitively expensive, and required communal that is not suited to farmers in isolated areas. Catholic Relief Services (CRS) has developed a simple, affordable, passive ventilation system which modifies traditional pit stores to provide multiple benefits. Farmers are experimenting with the system with varying degrees of success for the storage of potatoes and higher-value crops including apples, onions, cabbage, carrot, and turnip, with potential to increase market participation and household diet diversity.

Challenge

The CRS method involves **ventilating traditional potato pits** using the heat generated by the respiration of the tubers in the pit. Heat generated by the potato stack is captured in an airspace above the stack and, when released rapidly, sucks-in cool ambient air (approx. 4ºC at 10a during the winter months) to a vent along the base of the pit thus replacing the warm moist air and cooling the stack. See details in the CRS/UC Davis resource below. Using this method, the storage period has been extended from a maximum of three months to over six months, with losses consistently reduced to under 5%. Farmers benefit from increased food security and income, improved quality of their seed and greater flexibility in their cropping and selling practices. It costs $10 to modify a traditional pit containing 2 tonnes of potatoes. Modules can be added for the same cost to accommodate additional tonnage as necessary. Over the past three years there have been over 300 farmer replications of the modified store, but the adoption rate remains low, and application is limited mostly to potatoes.

Request

CRS is interested in advancing their innovation through applied research and development to 1) improve the adoption rate of the innovation, and 2) adapt or prove the efficacy of the innovation for other environmental conditions and crops. Technical areas of greatest interest include engineering design, thermodynamics, computational modeling, and construction. Examples of activities *include but are not limited to*:

- A human-centered approach to understanding end-users and other stakeholders, and recommending means to increase adoption
- Computational model of these pits that the couples air flow, humidity, and transpiration thermodynamics, and to use the model to adapt and optimize the innovation for varying environmental conditions or crops
- Applied construction research to improve build time and accessibility, for varying crops and locally available materials

Partner Support

CRS is able to provide in-kind support for this request through in-country staff collaboration and data collection with researchers. A staff focal point will be assigned to engage with researchers and respond to requests for information. Additionally, CRS will have nominal funding for any necessary field testing, communications expenses, and possible hosting of researchers in-country.

Relevant Resources

- Manual: Increasing Potato Yields Through Improved Potato Storage Pits (CRS / UC Davis)
- Technical Bulletin: Modified Heap and Pit Storage for Table and Processing Potatoes (CPRI #82)
- Report: Assessment of Potato Storage Facilities in Bamyan (SALEH/FAO)
- Refereed Journal Article: Non-Refrigerated Storage of Potatoes
- Refereed Journal Article: Design, construction and evaluation of an evaporative cooler for…sweet potatoes…
- Abstract: Harnessing potato respiration to drive the store ventilation system (Page 41, Abstract 34)

PARTNER CHALLENGE 3: Farm-Level Soil Mapping Technologies

Partner(s): Catholic Relief Services (CRS), Central America; Purdue Agronomy

Background

Catholic Relief Services (CRS) and Purdue University have worked with Central American governments to develop a Digital Soil Map for improving agricultural production systems. It is based on a continuous GIS model for predicting and mapping soil functional classes, developed using soil samples obtained in the field. The team has developed a method to map soil properties at local and regional scales, using minimal data. This method can produce accurate soil maps using fewer inputs and at lower cost than other available methods, but could be refined to be of higher value to plots as small as those of smallholder farmers, and made more objective and automated. The maps have served for better community decision-making around natural resource management, specifically:

- Watershed restoration to slow runoff and improve water recharge
- Irrigation efficiency and water harvesting
- Improvements in soil and crop management on-farm (greenwater focus)

Challenge

The method iteratively incorporates topographic indices and soil sample data, through a fuzzy logic algorithm. The topographic indices are derived from digital elevation models (DEM) such as the Shuttle Radar Topographic Mission (SRTM), which has been acquired for the majority of the globe and is publicly available. The algorithm then generates soil classes and delineates the polygons of the digital soil maps desired. These maps serve as a starting point to organize a soil sampling campaign to validate and refine the soil maps. Critically, it identifies the likely locations of the purest, most representative samples, minimizing the number of samples required for an accurate model. After soil samples are acquired, lab results (N, P, K, OM, CEC, pH, etc.) are entered and a relationship between the soil classes and these various soil properties is developed. Gridded datasets of each of the soil properties at the resolution of the input DEM can be generated by using these relationships to assign a value to each pixel based on its fuzzy membership values, though the accuracy of the data at any given point depends on the accuracy of the model. In its current state, a user with soils expertise must adjust various settings in the fuzzy classifier until the resulting maps satisfy their intuition. Present costs are associated primarily with expert labor for map production and, to a lesser extent, the acquisition and testing of soil samples. It is also challenging for stakeholders other than GIS experts to interpret and apply the resulting maps.

Request

CRS seeks expert assistance in 1) efficiently refining the accuracy of the models and making the process more objective and automated, 2), improving database practices for storage and interoperability, and 3) developing a software solution to assist non-experts in viewing, interpreting, and making decisions based on the soil maps that are produced.

Partner Support

Partner may be able to provide support, but this is currently not certain.

Relevant Resources

- Slides: GIS – Building Capacity to Improve the Environment (CRS)
- Refereed Journal Article: SoilGrids1km — Global Soil Information Based on Automated Mapping
- Refereed Journal Article: Multi-scale digital terrain analysis and feature selection for digital soil mapping
- Book Chapter: Current State of Digital Soil Mapping and What Is next

PARTNER CHALLENGE 4: Point-of-Care Device Suite, and Medical Diagnostics

Partner(s): To Be Determined.

*Excerpted from the **50 Breakthroughs Study**, #18, 20, 21, 22*

50 Breakthroughs (OpASHA)

Background, Challenge, and Request

#18 An integrated, easy to operate, affordable, and solar-powered suite of medical devices specifically for maternal, child and primary care in low resource settings.

“Currently, building a reasonably equipped clinic costs more than $100,000. In addition, essential devices are often difficult to install, complicated to use, and expensive to maintain. A suite of the key 10-15 devices that are designed for ease of installation and use (e.g., a ‘clinic-in-a-box’) and collectively cost $10,000 or less can serve as a building block for expanding healthcare in rural areas. Integration needs to occur with respect to power supply and management, patient data, diagnostics, and communication. Potential devices include: diagnostics for critical maternal conditions (malnutrition, anemia, malaria, HIV, syphilis, hypertensive disorders); sterilizers; ultrasound; devices to care for preterm or low birthweight infants (continuous positive airway pressure or CPAP, warmers if skin-to-skin warming is not possible, phototherapy); medical refrigeration; and ICT devices or interfaces for tracking patient data and coordinating care.”

#20 Automated and multiplex immunoassays that can test for a wide range of diseases, and are compatible with easily collected sample types.

“Currently, a patient presenting a particular symptom, for example fever, needs to be tested for the range of conditions that could cause the symptom—each with its own diagnostic—until a positive result is achieved. Most rural clinics serving low income patients do not have the necessary diagnostics available to test the full range of conditions linked to specific symptoms. As a result, some conditions are misdiagnosed, often resulting in inappropriate treatment. One common problem is presumptive treatment, which happens often in the case of malaria where the disease is endemic. Instead of being tested for the actual febrile illnesses they have, patients are simply treated for malaria. Point-of-care immunoassays that can use different types of samples (e.g., saliva, whole blood, urine), and test for multiple biomarkers from a single patient sample, represent a major breakthrough in diagnosis and patient care.”

#21 Point-of-care nucleic acid tests (NATs) that are simple, robust, and compatible with easily collected sample types.

“Nucleic acid tests (NATs) are a highly reliable method of detecting the presence of pathogens in a patient, by detecting the presence of the pathogen’s genetic material (DNA or RNA). This method can be used to accurately quantify the level of infection, identify pathogen strains, and determine drug resistance profiles, which is essential for diagnosing and treating diseases like TB and HIV. Currently, NATs are expensive and complex, and require trained laboratory technicians. They are mainly used in hospitals and centralized laboratories. Low cost point-of-care NATs represent a major breakthrough in disease detection. These tests should be compatible with simple sample types (such as whole blood), rapid, user-friendly for minimally trained technicians, robust (despite high heat and humidity), and not reliant on refrigeration, running water, or stable electricity.”

#22 Fully-integrated single-diagnostic platforms that eliminate the need for individual platforms for separate disease conditions.

“Even as progress is made on individual diagnostic technologies and platforms—immunoassays, nucleic acid tests (NATs), etc.—the ultimate breakthrough is a bench-top diagnostic platform that can integrate a wide variety of individual platforms such as optical readers (e.g., for HIV screening), bench-top chemistry analyzers, and NATs (e.g., for TB and viral load testing). Such a platform needs to perform all diagnostic test menus required at the point-of-care in peripheral health clinics. As with other point-of-care diagnostics, the ideal technology would be portable, rapid, not reliant on refrigeration, running water or grid electricity, able to function effectively in high heat and humidity, and easy to use for minimally trained technicians. It should cost no more than a few thousand dollars.”

Relevant Resources

- Report: Compendium of innovative health technologies for low-resource settings… (WHO, 2014)
- Report: 2010 Baseline country survey on medical devices (WHO) and 2014 Update
- Refereed Journal Article: Point-of-Care Diagnostics in Low Resource Settings: Present Status and Future Role…
- Refereed Journal Article: Low-cost technologies for medical diagnostics in low-resource settings

PARTNER CHALLENGE 5: Refrigeration for vaccines and agricultural products

Partner(s): To Be Determined.

*Excerpted from the **50 Breakthroughs Study**, #23, 26, and 27*

50 Breakthroughs (Bot: USAID)

Background, Challenge, and Request

#23Low cost off-grid refrigerators for preserving vaccines (and other temperature-sensitive pharmaceuticals) in remote settings.

"Vaccines and a number of other life-saving pharmaceuticals are highly temperature sensitive, making it very difficult to administer them in remote, low resource settings. Currently, most rural clinics have neither electricity nor refrigerators, and cannot provide vaccinations. The equipment used for vaccination outreach campaigns in remote areas—insulated boxes with freezer packs—is highly ineffective; many vaccines freeze, others get too warm, and outreach trips are limited to 1 or 2 days. A solar-powered vaccine refrigerator in the $500-$1,000 range will significantly improve the ability of remote clinics to immunize rural populations. A reliable, portable 'passive' cooling mechanism that is considerably less expensive (under $100) and can keep the vaccines from either freezing or getting too warm for several days, will also be very helpful."

#26 Low cost refrigerated vehicles, sturdy enough for unpaved roads in rural areas.

"The ability to transport food to markets while preserving its freshness will help farmers increase their incomes from higher-value produce like vegetables, fruit, meat, and dairy products. Currently, the absence of refrigerated transportation is one of the factors contributing to the lack of a market for such commodities. Refrigerated trucks available on the market today are unaffordable for small agribusiness entrepreneurs, and are generally built for paved roads. In order to be useful in sub-Saharan Africa, refrigerated transportation vehicles must be built for unpaved, rough terrain, and cost less than $5,000."

#27 Affordable off-grid refrigeration for smallholder farmers and small agribusinesses.

"The absence of affordable refrigeration and electricity severely limits the ability of smallholder farmers to produce, preserve and sell high-value perishable commodities like vegetables, fruits, meat and dairy. A new kind of refrigerator that costs less than $50 and can run on solar power will help smallholder farmers take such high-value commodities to market, thereby increasing their incomes."

Partner Support

Partner and support to be determined.

Relevant Resources

- Report: Cold Chain and Refrigeration (Powering Health, USAID)
- Refereed Journal Article: Evaluating the value proposition for improving vaccine thermostability…in [LMICs]
- Report Slides: Cold Chain Equipment Market Landscape. (Gates Foundation, 2013) and thermostability slides
- Refereed Journal Article: Advances in mathematical modelling of postharvest refrigeration processes
- Conference Article: Study of new cool storage materials for refrigerated vehicle in cold chain

PARTNER CHALLENGE 6: Smart Homes and Building Materials

Partner(s): To Be Determined

*Excerpted from the **50 Breakthroughs Study**, #8 and 44*

Background, Challenge, and Request

#8 A new generation of homes with advanced construction material, especially for the urban poor: durable, lightweight, and affordable, with integrated solar-powered lighting, ventilation, and toilets.

"The majority of the poor—particularly in urban areas—live in densely packed shacks made with found material, which have very limited light or ventilation, and no running water or sanitation. This contributes to a range of health problems such as TB, diarrheal disease, pneumonia, and other respiratory conditions. Improving living conditions by reinventing the home for the poor, with the characteristics listed [below], can significantly improve quality of life and is critical for improving health outcomes in developing countries."

- Very low cost, so that it is affordable for the poor (recognizing that it will often compete with free, found material).
- Robust, so that it withstands harsh weather, and can potentially support a duplex structure.
- Lighting and ventilation.
- Equipped with basic appliances, e.g., solar-powered LED lighting, and a fan.
- Equipped with a private in-home toilet, which can be used even without a connection to running water or drainage systems (in principal the waste can be extracted from outside the home, for disposal).
- Aesthetically pleasing and culturally appropriate.
- Lightweight, so that it can be relocated if necessary."

NOTE: solutions may include (but are not limited to) prefabricated walls or buildings, construction systems utilizing minimally skilled labor, retrofit kits, etc.

#44 Affordable homes that are resilient to extreme weather events, for the poor living in areas vulnerable to extreme weather.

"The increased frequency and intensity of extreme weather events is putting vulnerable communities at greater risk of losing their homes. It is unlikely that improved architecture with existing materials, by itself, will suffice. Improved materials are required for robust, affordable, environmentally and culturally compatible housing, and for designs that can scale-up to meet global demand."

"A breakthrough is needed to develop a functional, resilient, and very low cost housing system accessible to the global poor. Applied research is needed to identify appropriate types of building materials, and the scale and location of manufacturing facilities, in different social, geographical and cultural contexts. Trade-offs may exist between large-scale, centralized production versus smaller-scale decentralized production closer to end users. Trade-offs may also exist between production automation and local employment opportunities. The potential use of locally-available raw materials suggests that various geographically specific solutions may exist. Beyond material properties, sensitive design work is required to produce robust, efficient, comfortable, and culturally-appropriate housing solutions that can scale to the extent needed. Potential integration of renewable energy technologies, e.g., photovoltaic or solar-thermal collectors, could allow synergies between human development goals."

NOTE: solutions may include (but are not limited to) performance improvement of traditional (vernacular) building materials, new building materials or systems (especially for multi-story buildings), construction best practices adaptable to local conditions, etc.

Relevant Resources

- Report: Agenda 21 For Sustainable Construction in Developing Countries
- Reports: Practical Action - Construction and the Built Environment
- Refereed Journal Article: Appropriate Technology for Housing in Sudan: Evaluation of…Building Materials
- Refereed Journal Article: Offsite Manufacturing Construction: A Big Opportunity for Housing Delivery in Nigeria